WATER CONDENSOR APPARATUS

FIELD OF THE INVENTION

The present invention broadly relates to methods and apparatus for condensing water from ambient air and collecting the condensed water. The apparatus in at least one form provides a means for generating potable water for consumption or other purposes and finds particular application in areas where potable water supplies are limited.

BACKGROUND OF THE INVENTION

In many locations around the world access to a fresh potable water supply is limited, forcing many to use water for everyday needs that would not generally be deemed suitable for such use. Indeed, many water supplies are contaminated or polluted and in order to use the water safely, it is necessary for the water to be boiled or treated in some other way.

While yachts and ships carry their own water supplies during a voyage, it is often necessary to restrict daily usage of the available water due to access to fresh water supplies other than rainfall being unavailable. Similarly, mining operations or military camps in remote locations and, for example, island resorts, all have a need for fresh water.

Water, of course, has thousands of uses in addition to being required to sustain life. Such uses include washing and use in industrial processes amongst others. In areas or locations where the supply of water is limited, it is desirable to have access to regular supplies of fresh water. While supplies can be replenished by rain water, rainfall can be variable and insufficient. Moreover, the cost of transporting fresh water to remote locations can be expensive.

In United States patent No. 6,156,102 there is disclosed apparatus and methods for collecting water from ambient air involving passing the air into contact with a hygroscopic solution. The hygroscopic solution absorbs the moisture from the air, which is subsequently evaporated from the hygroscopic solution and collected. The evaporation of the moisture is achieved by heating the hygroscopic liquid or by evaporating the moisture under vacuum. A similar arrangement involving directing ambient air into contact with a sorbent material for absorption of moisture from the air prior to separation and collection of the absorbed moisture is described in United States patent No. 6,336,957.

Apparatus for condensing water from ambient air comprising a refrigeration system incorporating an electric compressor are described in European patent No. 0597716 and United States patent No. 5,857,344. The refrigeration systems cool ambient air by compression and subsequent expansion of a refrigerant to effect condensation of the water from the air. In each of these apparatus, the water is collected from the air and dispensed in the one location.

SUMMARY OF THE INVENTION

In a first aspect of the present invention there is provided a modular system for collecting water from ambient air and dispensing the collected water, the system comprising:

a condensor unit for condensing the water from the ambient air and collecting the condensed water, and including at least one condensation surface disposed for contact with the ambient air;

a refrigeration system for cooling the condensation surface to, or below, the dew point of the ambient air to effect the condensation of the water from the ambient air onto the condensation surface for collection, the refrigeration system being housed in the condensor unit and incorporating a compressor for compressing a refrigerant vapour and a condensor for condensing the compressed refrigerant vapour into liquid refrigerant; and

at least one dispenser unit adapted for being located remotely from the condensor unit for receiving the condensed water from the condensor unit and dispensing the water, wherein the dispenser unit is adapted for storing the water and/or recirculating at least some of the water.

The dispenser unit may be demountable from the condensor unit for being located remotely from the condensor unit if desired. That is, an embodiment of the modular system may be provided as a single unit for condensing the water from the ambient air and dispensing the water in the one location, or the dispenser unit can be detachably removed from the dispenser unit and located at another location. In an alternative embodiment, the dispenser unit and the condensor unit are provided as entirely separate units.

As the water can be dispensed remotely from where it is condensed from the ambient air and collected, the condensor unit can be located outside of a building where it is exposed to prevailing atmospheric humidity conditions, while the dispenser unit may be located within the building. As the ambient environment in many buildings is air-conditioned and the humidity in the building controlled, locating the condensor unit outside enables water production to be maximised. Locating the condensor unit outside also removes any noise

associated with the operation of the refrigeration system of the condensor unit to outside the building.

Accordingly, in another aspect of the present invention, there is provided a modular system for collecting water from ambient air, the system comprising:

a condensor unit for condensing the water from the ambient air and collecting the condensed water, and including at least one condensation surface disposed for contact with the ambient air;

a refrigeration system for cooling the condensation surface to, or below, the dew point of the ambient air to effect the condensation of the water from the ambient air onto the condensation surface for collection, the refrigerant system being housed in the condensor unit and including a compressor for compressing a refrigerant vapour and a condensor for condensing the compressed refrigerant vapour into liquid refrigerant; and

at least one dispenser unit located remotely from the condensor unit for receiving the condensed water from the condensor unit and dispensing the water, wherein the dispenser unit is adapted for storing the water and/or recirculating at least some of the water.

Preferably, the condensor will be arranged for contact with ambient air flowing from the condensation surface for cooling the refrigerant vapour to facilitate the condensing of the refrigerant vapour.

Preferably, the condensor unit will also include a water circulation system, comprising a holding tank for receiving the collected water, and a pump for pumping the water from the holding tank to the dispenser unit. Preferably, the water circulation system will incorporate at least one ultraviolet (UV) light treatment unit for treating the water in the condensor unit with ultraviolet light to kill or inactivate bacteria and/or other microorganisms that may be present in the water, prior to the water being pumped by the pump from the condensor unit to the dispenser unit.

Preferably, the dispenser unit will be provided with at least one indicator for providing an indication of a corresponding operational parameter of the modular system. In a particularly preferred embodiment, the dispenser unit will be provided with a plurality of such indicators, each indicator providing an indication of a different operational parameter, respectively. For instance, an indicator may provide an indication of water availability from the condensor unit, low water level in the condensor unit, air or water filter status in the condensor unit to indicate whether the filter requires cleaning or replacing, or other such operational parameter or status.

The dispenser unit may comprise a dispenser body and a storage reservoir for storing water received from the condensor unit, wherein the storage reservoir is detachably removable from the dispenser body. Preferably, the storage reservoir and the dispenser body will mate together such that the storage reservoir is retained in position by the dispenser body. Typically, the storage reservoir will have a dispensing valve for dispensing the water. In a particularly preferred embodiment, the dispenser body will also be adapted for dispensing water on demand following removal of the storage reservoir from the dispenser body.

Moreover, an embodiment of the invention may comprise a control system for controlling flowrate of the ambient air into contact with the condensation surface, the control system comprising:

a temperature sensor for indicating temperature of the ambient air flowing from the condensation surface; and

control means for monitoring the temperature indicated by the temperature sensor and adjusting the flowrate of the ambient air flowing into contact with the condensation surface in response to the monitored temperature, to promote condensation of the water from the ambient air onto the condensation surface.

In addition, the condensor unit may be provided with at least one adjustable air intake operable by the control system to allow ambient air to flow to the condensor by-passing contact with the condensation surface such that a flowrate of ambient air flowing into contact with the condensor is adjusted relative to that of ambient air flowing from exterior of the condensation unit into contact with the condensation surface. This allows increased air flow past the condensor for cooling the condensor to enable refrigerant vapour in the condensor to condense into liquid refrigerant, without increasing the rate of flow of the ambient air from the condensation surface and thereby adversely affecting condensation of water from the ambient air onto the condensation surface.

Preferably, the control system will also comprise a further temperature sensor arranged to monitor temperature of the refrigerant vapour in the condensor and a pressure sensor for measuring pressure within the condensor, the control means being adapted to assess the temperature monitored by the further temperature sensor and the pressure measured by the pressure sensor, and operating the adjustable air intake in the condensor unit to alter the flow rate of the ambient air flowing to the condensor.

In another aspect of the present invention there is provided a dispenser unit for dispensing water received from a stand alone water collection unit, the dispenser unit comprising at

least one valve for dispensing the water and being adapted for storing the water until use and/or recirculating at least some of the water to the water supply unit.

In yet another aspect of the present invention there is provided water collection apparatus for collecting water from ambient air, the apparatus comprising:

at least one condensation surface disposed for contact with the ambient air;

at least one adjustable air intake; and

a refrigeration system for cooling the condensation surface to, or below, the dew point of the ambient air to effect the condensation of the water from the ambient air onto the condensation surface for collection, the refrigerant system including a compressor for compressing a refrigerant vapour and a condensor for condensing the compressed refrigerant vapour into liquid refrigerant;

wherein the condensor is arranged for contact with ambient air flowing from the condensation surface, and the air intake is operable to allow ambient air to flow to the condensor by-passing contact with the condensation surface such that a flowrate of ambient air flowing into contact with the condensor is adjusted relative to ambient air flowing from exterior of the apparatus into contact with the condensation surface.

In yet another aspect of the present invention, there is provided a water treatment device for treating water with ultraviolet light, the apparatus comprising:

an ultraviolet light source for providing the ultraviolet light;

a hollow member defining a treatment chamber with an inlet for entry of the water into the treatment chamber and an outlet for passage of the water from the treatment chamber, and which is transparent to the ultraviolet light; and

an inducer element arranged for inducing spiral flow of the water along the treatment chamber;

wherein the ultraviolet light source is arranged for irradiating the water with the ultraviolet light as the water flows along the treatment chamber.

The spiral flow of the water along the treatment chamber mixes the water and maximises exposure of the water to the UV light and thereby treatment of the water with the UV light. Preferably, the inducer element will comprise a stationary spiral element arranged within the treatment chamber in a fixed position for inducing the spiral flow of the water along the treatment chamber as the water flows past the spiral element. In a particularly preferred embodiment, the spiral element will comprise a plate twisted into a spiral with a longitudinal axis directed along the treatment chamber. Alternatively, the inducer element

may comprise a rotor which is rotatably mounted in the treatment chamber for being rotated as the water flows past the rotor.

Preferably, the water treatment device will further comprise a holder which holds the UV light source and the hollow member defining the treatment chamber in position alongside one another.

Preferably, the water treatment device will also be provided with a reflector for reflecting incident UV light from the UV light source into the treatment chamber. Typically, the reflector will be arranged in the holder behind the UV light source and lie alongside the UV light source for reflecting the UV light forward into the treatment chamber.

Condensing water from ambient air provides a way of supplementing fresh or stored water supplies in remote or extreme locations where fresh water is scarce or otherwise unavailable, and may reduce reliance on, or the need for, water to be transported to such locations. Similarly, where it is necessary to carry water supplies such as on a ship or boat during a voyage, condensing water from ambient air provides an alternative source of water during travel and so allows less reliance to be placed on stored water. Indeed, by being able to condense water from ambient air, stores of water may be reduced. In addition, condensing water from air provides some certainty as to the quality of the water, and provides a source of water in areas where there is doubt as to the quality of the existing water supplies or the available water is known to be polluted or contaminated, or is otherwise not suitable for the intended purpose of the water. Accordingly, one or more embodiments of the present invention find application in a number of practical situations.

Throughout this specification the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

All publications mentioned in this specification are herein incorporated by reference. Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed in Australia or elsewhere before the priority date of each claim of this application.

The features and advantages of the present invention will become further apparent from the following description of preferred embodiments of the present invention together with the accompanying drawings.

BRIEF DESCRIPTION OF THE FIGURES

FIGURE 1a is a perspective view of a condensor unit and a dispenser unit of a modular system embodied by the invention for condensing water from ambient air and dispensing the collected water;

FIGURE 1b is a perspective view of another dispenser unit embodied by the invention for receiving water from the condensor unit of Fig. 1a;

FIGURE 2a is a perspective view of a further embodiment of a modular system of the invention;

FIGURE 2b shows the modular system of Fig. 2a with the storage bottle of the dispenser unit removed;

FIGURE 3a is a perspective view of a further embodiment of a dispenser unit of the invention;

FIGURE 3b is a perspective view of the dispenser unit of Fig. 3a with the storage bottle removed;

FIGURE 4 is a schematic diagram showing components of the condensor unit of Fig.1;

FIGURE 5 is a schematic diagram of the refrigeration system of the dispenser unit of Fig. 1;

FIGURE 6 is a schematic diagram showing a water circulation system of the dispenser unit of Fig. 1;

FIGURES 7 to 9 are flow diagrams illustrating the operation of another embodiment of the invention;

FIGURE 10 is a partial side view of an ultraviolet light treatment unit for irradiating water collected by the dispenser unit of Fig.1 with ultraviolet light;

FIGURE 11 is a partial side view of an inducer element for introducing spiral flow into water flowing through the kill chamber of the ultraviolet light treatment unit of Fig. 10;

FIGURE 12 is a plan view of a rotor for generating spiral flow of water collected by the dispenser unit of an embodiment of the invention, for facilitating treatment of the water with ultraviolet light;

FIGURE 13 is a plan view of the holder of the ultraviolet light treatment unit of Fig. 10;

FIGURE 14 is a schematic view showing indicators for indicating the status of various operational parameters of a modular system for condensing water from ambient air embodied by the invention;

FIGURE 15 is a schematic view of water level sensing apparatus;

FIGURE 16 is a circuit diagram of a sensing circuit of the water level sensing apparatus of Fig. 15; and

FIGURE 17 is a schematic view of a yet further dispenser unit embodied by the invention.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

A condensor unit 10 of an embodiment of a modular system 12 for condensing water from ambient air is shown in Fig. 1a together with a dispenser unit 14. The condensor unit 10 houses a refrigeration system 16 which cools ambient air entering the housing 18 of the condensor unit through vent openings 20 to, or below, the dew point of the water, causing water vapour in the air to condense within the condensor unit 10 where it is collected. Water collected in the condensor unit is subsequently pumped through a feed conduit indicated by numeral 22 to the dispenser unit 14 for being dispensed when required. The condensor unit 10 is located externally of the building generally indicated by numeral 24, and is thereby exposed to the prevailing atmospheric humidity conditions for maximising collection of water from the ambient air.

The dispenser unit 14 shown in Fig. 1a is a wall mounted unit located internally in the building and comprises a dispenser body 26, and a storage reservoir in the form of a bottle 28 with a dispensing valve (not shown) located in a lower region of the bottle which is operable to dispense water from the bottle. The storage bottle has an upper recess indicated by numeral 30 which is contoured to match the front region 32 of the dispenser body, and an opening defined in the topside thereof for receiving water from the dispenser body. The dispenser unit 14 and storage bottle 28 mate together such that the storage bottle is retained in position on the dispenser body. The dispenser body incorporates a primary dispensing valve operable by a user to dispense water on demand into the storage bottle through the

opening defined in the topside of the bottle, or into a cup or other receptacle placed under the dispenser unit following removal of the bottle. The primary dispensing valve may comprise any suitable conventional mechanical or electrically operated (eg solenoid) valve system. Accordingly, the dispenser unit 14 provides for dual operation. That is, firstly collection and subsequent dispensing of water from the storage bottle 28 under gravity and secondly, removal of the storage bottle and dispensing of water on demand directly from the dispenser body.

The dispenser unit 14 shown in Fig. 1b is not provided with a storage bottle but rather, has a downwardly projecting base 36 with a rest 38 for the placement of a cup to be filled with water from the dispenser body. As with the dispenser unit shown in Fig. 1a, the dispenser body 26 is provided with a valve operable to release water from the dispenser body under gravity into the cup or other receptacle when placed on the rest 38. Each dispenser body of these apparatus comprises an internal water storage compartment for storing a predetermined amount of water from the condensor unit and from which the water flows upon operation of the main valve by the user into the storage bottle 28 or cup when provided.

An inlet allows water to flow into the water storage compartment and pool within the dispenser body until required by the user. An outlet is provided at an elevated position relative to inlet, through which water returns from the dispenser body to the condensor unit through a return conduit upon the water level in the storage compartment rising to the outlet. Water is, therefore, continuously recirculated from the dispenser body to the condensor unit as further described below.

Another embodiment of a modular system of the invention for condensing water from ambient air is illustrated in Fig. 2a. As shown, the dispenser unit 14 is mounted on the condensor unit 10 and is detachable therefrom as a single unit for being located remotely from the condensor unit if desired. As with the dispenser unit shown in Fig. 1a, the storage bottle is removable from the dispenser body such that the water may be independently dispensed on demand from the dispenser body itself. Hence, the dispenser body may be used independently of the storage bottle 28 as indicated in Fig. 2b. In this embodiment, the recess 40 defined in the condensor unit 10 for reception of the storage bottle 28 provides a platform 42 on which a cup or other receptacle may be placed before being filled with water from the dispenser body 26. The platform 42 is corrugated and has a raised outer peripheral rim for containing any spilt water. When the dispenser unit is removed from the condensor

unit, a matching cover may be fitted or clipped onto the condensor unit to enclose the recess and protect the condensor unit from the environment.

A further dispenser unit 14 is shown in Fig. 3a. As with the embodiment shown in Fig. 1a, this unit is a wall mounted unit with a removable storage bottle 28, but differs in that rear region of the dispenser unit 14 is received in a cavity defined in the interior wall 44 on which the dispenser unit is mounted such that the front region 46 of the unit is flush against the wall. As shown more clearly in Fig. 3b, a channel 48 is defined in each side of the storage tank which receive corresponding guides 49 provided in the recess 50 of the dispenser unit for retaining the storage tank in position within the unit. Further support of the storage bottle 28 is provided by the shelf 52 of the dispenser unit 14 on which the bottle rests.

In this embodiment, the dispenser unit 14 is mounted above a basin 54. A user may, therefore, wash their hands in the basin 54 using mains water from the tap 56 but drink the potable water from the dispenser unit.

A schematic diagram illustrating the components of the condensor unit 10 is shown in Fig. 4. More particularly, and as indicated in the figure, the housing 18 of the condensor unit 10 incorporates a compartment 58 housing an evaporator 60 and a condensor 62 of the refrigeration system. Ambient air A is drawn through an air filter 63 and then flows to the evaporator 60 after entering the vent openings 20 of the housing 18. As the air passes between spaced apart fins of the evaporator defining condensation surfaces, it contacts the condensation surfaces causing the air to be cooled to, or below, the dew point of water vapour in the air and thereby, water to condense from the air onto the condensation surfaces. The condensed water falls by gravity to the collector 64 in the form of a funnel, then passes through heat exchanger 66 and negative pressure trap 68 to a holding tank 70 (see Fig. 6) via conduit 72.

The cooled air leaving the evaporator 60 passes to the condensor 62, drawing off heat from the condensor. This in turn facilitates cooling of hot refrigerant vapour contained within the condensor which then condenses to a hot liquid refrigerant. The warmed dry air which leaves the condensor 62 is then extracted from the compartment 58 and exhausted to the atmosphere by a fan 74. As will be understood, the fan provides a negative pressure in compartment 58 which draws the ambient air A into the compartment through evaporator for further condensation of water from the air.

The refrigeration system 16 comprises an electrically powered compressor, and the compressor and additional components of the system are contained in a further compartment 75 within the housing 18 of the condensor unit. The refrigeration system may be either a single pressure or dual pressure system, and provides sub-cooled liquid refrigerant to the evaporator for evaporation within the evaporator to effect the cooling of the evaporator for condensation of the water from the ambient air. The resulting heated refrigerant vapour is drawn from the evaporator and passed to the condensor 62 for condensation to hot liquid refrigerant as described above. To enhance thermal efficiency, heat is drawn from the hot liquid refrigerant by the cool condensed water passing through heat exchanger 66. This cools the liquid refrigerant prior to the liquid refrigerant being recycled to the evaporator as described in more detail below with reference to Fig. 5.

As shown in Fig. 5, the heated refrigerant vapour is drawn through suction loop 76 from the lower region of the evaporator 60 to the electrically powered compressor 78. The suction loop 76 traps and holds any liquid refrigerant which might pass from the evaporator, thereby preventing the liquid refrigerant from entering and potentially damaging the compressor 78. The refrigerant vapour is compressed and thereby heated in the compressor, prior to being discharged through hot gas loop 80 to the top of the condensor 62. The hot gas loop 80 traps any liquid refrigerant draining back from the condensor 62 to the compressor 78.

The air drawn to the condensor 62 by the fan 74 cools the high pressure hot refrigerant vapour in the condensor such that the refrigerant vapour condenses. The condensed liquid refrigerant is then cooled by the condensed water passing through the heat exchanger 66 as described above. The cooled liquid refrigerant subsequently drains from the bottom of the condensor 62 into reservoir 82, prior to passing from the reservoir through a filter 84 which removes any contaminants and moisture from the liquid refrigerant. From the filter 84, the refrigerant travels along tubing 86 incorporating a sight glass 88 which allows a visual check for the presence of any moisture or bubbles in the liquid refrigerant.

The tubing 86 then feeds the dry, cooled liquid refrigerant to a thermostatic expansion valve 90. As the liquid refrigerant passes through the valve, the pressure of the liquid refrigerant decreases. The resulting low pressure cold liquid refrigerant with some flash gas is fed from the expansion valve 90 into the evaporator 60 where the liquid refrigerant evaporates back into refrigerant vapour, drawing in heat from the condensation surfaces of the evaporator effecting cooling of the ambient air and condensation of the water therefrom onto the condensation surfaces.

For efficient operation of the condensor unit, the flowrate of the ambient air A through the compartment 58 is adjusted to optimise condensation of water per unit volume of the ambient air flowing through the evaporator 60, while maintaining sufficient airflow to the condensor for heat transfer from the condensor to the air for achieving the condensing of the refrigerant vapour in the condensor. As will be understood, the refrigeration system 16 operates to cool the condensation surfaces of the evaporator without freezing the condensed water.

For any given prevailing atmospheric conditions, there is a specific humidity value measured in grams of water vapour per kilogram of the air. For example, a specific humidity of between 4.5 and 6 grams of moisture per kilogram of air correlates to a dry bulb temperature of between 1° C and 6.5° C. In use, the condensor unit 10 is operated to condense water from the ambient air entering the condensor unit such that the specific humidity of the air flowing from the evaporator to the condensor is reduced to a specific humidity correlating with a selected reference dry bulb temperature. The selected dry bulb temperature will typically be in the above temperature range and usually, will be in a range of from about 3.5°C to about 5.5°C and preferably, will be about 5°C or below.

A temperature sensor 92 is provided in the condensor unit 14 for measuring the dry bulb temperature of the air passing from the evaporator 60 to the condensor 62 (see Fig. 4). This temperature is compared in control module 94 with the selected reference dry bulb temperature which has been manually set in the control module. If the dry bulb temperature measured by temperature sensor 92 increases above the set reference dry bulb temperature, the control module operates actuator 96 such that air intake 98 in the form of a hinged damper opens allowing ambient air A to be drawn into compartment 58 of the housing 18. This decreases the flowrate of the ambient air A being drawn into the evaporator which in turn lowers the dry bulb temperature of the air leaving the evaporator.

As the flowrate of the air leaving the evaporator is decreased, the amount of cooled air from the evaporator available for cooling the condensor also decreases. This results in a rise in the pressure of the refrigerant vapour in the condensor above the optimum pressure for the fixed refrigeration capacity of the refrigeration system 16. The pressure of the refrigerant vapour in the condensor is measured by a pressure sensor 100. In response to the increased pressure measured by the pressure sensor, the control module 94 increases the speed of the fan 74 via controller 102 and operates actuator 96 to further open the air intake 98 to increase the flowrate of air flowing to the condensor, while simultaneously substantially maintaining the flowrate of the ambient air A through the evaporator. The increased flowrate of air to the

condensor removes heat from the condensor such that the pressure of the refrigerant vapour in the condensor reduces to the optimum pressure for the fixed refrigeration capacity of the refrigeration system.

The control module 94 continues to monitor the dry bulb temperature of the air leaving the evaporator and the pressure of the refrigerant vapour in the condensor respectively measured by temperature sensor 92 and pressure sensor 100. If the dry bulb temperature sensed by the temperature sensor decreases below the set reference dry bulb temperature, the control module 94 operates to decrease the speed of the fan and activate the actuator 96 to partially or completely close the air intake 98 such that the flowrate of the ambient air into the dispenser unit 14 decreases.

The monitoring is repeated at regular intervals to ensure optimum efficiency of the apparatus and thereby, maximum condensation of water from the ambient air. The provision of such timing circuits is well within the scope of the skilled addressee. For different latitudes or atmospheric conditions, the reference dry bulb temperature set in the control module 94 may be adjusted. The operation of an embodiment of the invention is exemplified in Fig. 7 to Fig. 9.

Returning now to Fig. 6, the condensor unit 10 further incorporates a water circulation system 104. This system includes a holding tank 70 which receives the condensed water from the collector 64 (see Fig. 4). A pump 106 draws water from the holding tank 70 and pumps the water through conduit 108 to T-connector 110. Some of the water continues along conduit 108 to ultraviolet light treatment device 112 where the water is irradiated with UV light at a wavelength of 253.7 nm prior to being returned to holding tank 70. As will be understood, treatment with the UV light kills bacteria and other pathogens which may be present in the water.

The remainder of the water entering the T-connector 110 is diverted to junction 114 comprising a further T-connector, where the water is directed to float valve 116 or activated charcoal filter 118, or both. If there is sufficient water in holding tank 70 to allow water to pass from the condensor unit 10 to the remotely located dispenser unit 14, the float valve 116 closes the end 122 of pipe 124. The float valve 116 comprises a float 126 carried on the end of float arm 128. The float arm is pivotally hinged at an opposite end to the interior of the holding tank 70. As the water level rises in the holding tank, the float 126 rises causing sealing washer 130 carried by valve body 132 to be pressed against the end 122 of the tubing 124 as the float arm 128 is lifted by the float, preventing water from flowing back into the

holding tank 70. When system valve 134 is open, the water pressure generated by the action of the pump 106 forces water through filter 118 and auxiliary UV light treatment device 136, prior to passing to the dispenser unit 14 through feed conduit 22 (see Fig. 1a).

The feed conduit 22 comprises a flexible hose connected to the condensor unit 10 and the dispenser unit 14 by fittings (eg. bayonet) which sealingly couple with corresponding female fittings on the condensor unit and dispenser unit. As indicated above, a return conduit in the form of a flexible hose (not shown) for recirculating excess water from the dispenser unit to the holding tank 70 via a return pipe in the condensor unit is also provided. Accordingly, water continually flows back and forth between the condensor unit 10 and the dispenser unit 14. The water is, therefore, treated with UV light each time it is recirculated through the condensor unit before being returned to the dispenser unit. As with the feed conduit, the return conduit is coupled to the condensor unit and dispenser unit by mating connectors.

As water is pumped from the holding tank 70 in the condensor unit to fill the storage bottle 28 of the remotely located dispenser unit 14, or to otherwise meet demand for the water, the water level in the holding tank lowers and the float valve starts to open allowing a portion of the water pumped to junction 114 to discharge through the partially opened end 122 of pipe 124. As a result, the water pressure of the water passing through system valve 134 decreases and the flowrate of the water to the dispenser unit decreases accordingly. The flowrate continues to decrease until eventually the float valve is fully opened and insufficient water pressure is available to pump water through the system valve. However, sufficient water remains in the storage tank 70 to allow re-circulation of the water through the UV light treatment device 112, but water cannot be pumped to the remote dispenser unit 14 until more condensed water enters the storage tank from the collector 64.

The UV light treatment device 112 is illustrated in Fig. 10 and comprises an ultraviolet lamp 138 mounted in a holder 140 incorporating a reflector 142. Lamp sockets 144 receive the UV lamp and are arranged within the holder 140, one at each end of the UV lamp respectively, and facilitate electrical connection to the lamp. A quartz tube 146 defining a treatment chamber for passage of the water is received by top and bottom elbows 148 and 150 which hold it in position in front of the UV lamp 138. One elbow is mounted on each end plate of the holder, respectively. A resilient washer (not shown) between each end of the quartz tube and the corresponding elbow prevents water leakage.

The bottom elbow 150 incorporates an inducer element for inducing spiral water flow in the treatment chamber. The inducer element 152 comprises a plate member 154 twisted into a spiral and which is held in a fixed position on the end of a stem 156 projecting from a base 158 of the inducer element. In use, the water enters inlet 160 defined in the body 161 of the bottom elbow which directs the water into contact with the twisted plate member 154 of the inducer element in the treatment chamber. The width of the plate member substantially corresponds to the diameter of the treatment chamber. As the water flows over the plate member, spiral water flow is induced along the treatment chamber. This mixes the water and maximises exposure of the water to the UV light, and thereby treatment of the water. The reflector 142 enhances treatment of the water by reflecting lateral UV light back onto the treatment chamber. As also shown in Fig. 10, one or more further reflectors may be provided for reflecting incident UV light back onto the treatment chamber.

A partially exploded view of the bottom elbow 150 is shown in Fig. 11. As indicated in the figure, a groove 164 receiving an O-ring 166 is defined in the base 158 of the inducer element 152 for preventing water leakage between the base 158 and the body 161 of the bottom elbow. A male thread 168 defined on the base 158 engages with a corresponding female thread defined in the interior of the body 161. Rather than a stationary plate member 154 twisted into the form of a spiral, the inducer element may incorporate a rotor of the type illustrated in Fig. 12 rotatably mounted on the end of the stem 156 of the inducer element and which is rotated as the water passes from the bottom elbow into the kill chamber for achieving the spiral flow of the water.

An end view of the holder 140 of the UV light treatment unit 112 is shown in Fig. 13. As can be seen, a hole 170 is defined in each end plate of the holder for reception of the corresponding elbow 148 or 150. The reflector is formed from stainless steel sheet and has opposing outwardly directed side arms 172. The side arms are inclined relative to one another and extend substantially along the entire length of the holder 140. The rear 174 of the reflector stands against the interior face of the holder and is held in position by reception of the lamp sockets 144 through corresponding openings (not shown) defined in each end region of the reflector. The auxiliary UV treatment device 136 has the same construction as that shown in Fig. 10.

As indicated in Fig. 14, the dispenser unit 14 is provided with an array of indicator lamps for indicating the operational status of various parameters of the modular system. In the particular example illustrated, separate indicator lamps are provided for indicating whether the holding tank 70 is full or empty, whether water is available from the holding tank 70,

whether the air filter 63 or water filter 118 in the dispenser unit need cleaning or changing, and whether there is a fault in the modular system, respectively. Relevant ones of the indicator lamps 176 are lit in response to frequency encoded signals received by an electronic frequency decoder 178 housed in the dispenser unit from an electronic frequency encoder 180 housed in the dispenser unit. The signals pass from the frequency encoder 180 to the frequency decoder 178 via twisted pair electrical wires connecting the frequency encoder to the frequency decoder.

Input signals to the frequency decoder 180 are provided from switches arranged for indicating the status of the parameters being monitored. For instance, a float switch for indicating the holding tank 70 is full may be located within the holding tank such that when the water level rises to the holding capacity of the holding tank 70, the float switch closes providing a signal to the frequency encoder 180 which in turn transmits a signal to the frequency decoder which causes the relevant lamp 176 to light indicating the storage tank is full. When the float switch closes, the operation of the compressor is also stopped which in turn stops condensation of water and the storage tank from filling further. An overflow outlet defined in the holding tank 70 and which leads to a drain is also provided as a safeguard. When the level of water in the holding tank falls, the float switch opens and the compressor 78 recommences operation.

Similarly, a float switch or other suitable switch may be located in a lower region of the holding tank 70 for indicating low water level. A yet further such switch may be located slightly higher than the tank for indicating water availability. Switches which may be used for these purposes include switches which are short circuited and thereby closed by contact with water.

The flow of ambient air through the evaporator 60 in use will generally be within predetermined upper and lower limits. To indicate that the air filter needs cleaning or replacing, a sail switch is provided between the air filter and the evaporator 60. When the flow rate of the ambient air decreases below the normal operating range, movement of the sail closes a contact generating a signal to the frequency encoder 180 which in turn causes the corresponding indicator lamp 176 on the remotely located dispenser unit 14 to light. Of course, rather than using switches which are normally open, switches which are normally closed and cause a signal to be generated upon being opened may be utilised instead.

Rather than a flow switch, a timer comprising a timing circuit for timing hours of operation of the dispenser unit is used for generating a signal to the frequency encoder 180 for causing

the indicator lamp 176 on the dispenser unit for indicating the water filter 118 requires attention. At the end of a predetermined time limit which may be several months or more in length, a signal is generated by the timer for causing the corresponding indicator lamp 176 to light.

Instead of switches, a water level sensing and switching apparatus may be utilised for monitoring the depth of water in the holding tank 70 as shown in Fig. 15. The sensing apparatus comprises an upright cylinder 184 arranged in the holding tank to receive the condensed water from the collector 64 of the condensor unit 10. Two closely spaced reference electrodes 186 are located in the cylinder. The cylinder fills with water from the collector 64 until depth h1 is reached which represents the maximum water depth the cylinder can hold. As more water drains into the cylinder, water begins to overflow from the cylinder through overflow tube 188 into the holding tank 70. The reference electrodes 186 are connected to an electronic sensing circuit through wires 190 and provide a reference conductive resistance.

A pair of conductive electrodes 192 which are identical to reference electrodes 186 are mounted in the storage tank 70 at the same vertical position as reference electrodes 186. With no water in the storage tank 70, the electrical resistance between conductive electrodes 192 is infinite. As water enters the tank from overflow tube 188, the water level represented by h2 rises and lowers the conductive resistance between the conductive electrodes. The conductive electrodes are also connected to the sensing circuit.

When the holding tank 70 is full, the conductive resistance across conductive electrodes 192 is substantially identical to that across the reference electrodes 186. As the depth of water falls in the holding tank 70, the resistance between conductive electrodes 192 changes. The depth of water in the holding tank is determined by the sensing circuit by comparing the conductive resistance across the conductive electrodes 192 with the conductive resistance across the reference electrodes 186.

The sensing circuit is illustrated in Fig. 16 and senses the depth of water in the holding tank as follows. The combination of resistor R1 and the resistance from reference electrodes 192 in series provides a reference voltage +Vref at point X in the circuit. +Vref is applied to two or more comparators (CP1, CP2, CP3) through resistance ladder made up of R3, R4, R5. The values of each resistor in the ladder are selected to provide reference inputs to each comparator equal to a known proportion of +Vref (eg, 1/4, 1/2 of +Vref). The combination of

variable resistor R2 and the resistance from conductive electrodes in series provides a variable voltage +Vvar at point Y in the circuit.

+Vvar is applied to the second input of each comparator. As +Vvar changes with the change in water depth in the holding tank 70, the pre-set voltage ladder determines which comparator switches on or off. The presence or absence of voltage output from each comparator turns indicators in the form of light emitting diodes arranged on the dispenser unit on or off, thus indicating the depth of water in the storage tank 70 in the condensor unit. The output from a comparator may also control a function of the condensor unit, such as turning the condensor 10 and fan 74 off when the storage tank is full. For calibration purposes, variable resistor R2 is adjusted with both pairs of electrodes 186 and 192 fully immersed in water of the same quality to achieve +Vref equal to +Vvar.

Another embodiment of a dispenser unit 14 is illustrated schematically in Fig. 17. In this embodiment, the dispenser body comprises a recess 194 receiving a storage tank 195 on platform 196. The platform 196 of the dispenser unit is mounted on a plurality of support springs 198. A valve mechanism 200 is positioned at the upper rear of the recess and is arranged to open and sealingly close outflow opening 202. The valve mechanism comprises an actuator arm 204 and a closure arm 206 which pivot about pivot pin 208. A spring 210 biases the closure arm against the outflow opening. When the storage tank 195 is received in the recess 194 of the dispenser unit as shown in the figure, the actuator arm 204 of the spring mechanism compresses the spring and the closure arm 206 is rotated about the pivot 208 opening the outflow opening. This allows water which has entered storage compartment 211 of the dispenser unit through inlet 212 from the remotely located condensor unit 10 and overflowed pipe 214, to flow from outflow opening 202 into the storage tank through an opening 216 defined in the storage tank. The mass of the storage tank is sufficient to maintain the valve mechanism in the open position.

As the storage tank fills with water, the support springs 198 compress and the platform 196 lowers within the recess 194 of the dispenser body. When the storage tank is full, the actuator arm 204 of the valve mechanism is released allowing the closure arm to pivot about the pivot pin 208 and sealingly close the outflow opening 202, preventing the flow of further water from the storage compartment 211 of the dispenser body 26 through the outflow opening. With closure of the outflow opening, water entering the storage compartment 211 accumulates raising the level of the water in the storage compartment to the outlet 216. Excess water then flows from the outlet and is recirculated to the condensor unit as described above.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the spirit or scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative and not restrictive. For instance, rather than the dispenser unit 14 storing condensed water from the condensor unit, all of the water may be recirculated directly back to the condensor unit if not dispensed immediately from the dispenser unit on demand from a user.